The Handset Power Amplifier using Continuous Bias Control

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Abstract: A MMIC PA with continuous bias Control circuit for cellular handsets has been implemented. It has been shown that power amplifier with continuous bias control circuit can increase the standby and talk time by lowering the average current consumption. The average current of the continuous bias control is 37.9mA in urban and 59.2mA in suburban CDMA environment, which is reduced by 45.9% and 60.6%,respectively compared to normal operation (no bias control). The ACPR is below 47.3dBc, and the PAE is about 42.3% in both operations.

1. Introduction

Recent mobile handsets for CDMA systems require highly linear and efficient PAs in order to maximize the standby and talk times. Most power amplifier for CDMA Handset applications must be designed and manufactured to meet certain maximum output power specification (linearity and efficiency at 28dBm of typical CDMA IS-95 standard)[1]. In general, the power amplifiers deliver usually a high efficiency only at near the maximum rated power level, and the efficiency drops drastically as the output power level is reduced. The power amplifier consumes high currents compared with its output power at low power levels. Therefore, we can increase the talk-time by reducing the current at the low power level. Fig. 6 shows the relationship between the probability distribution function (PDF) and the power amplifier output for a typical CDMA mobile phone [1], [2], [3].

This paper proposes a power amplifier with continuous bias control circuit to increase the standby and talk time by lowering the average current consumption.

2. Design & Implementation

Fig. 1 shows the designed power amplifier schematic. This PA consists of 2stage power amplifier and bias control circuit which controls the bias circuit of power stage according to the output power. The control voltage (Vctrl) is available from the base-band controller of handset system. All the part of PAM except output matching is integrated in MMIC chip. The capacitor and ballasting resistor are used for input matching, and inter-stage matching is consisted of a series capacitor and a parallel inductor. Fig. 2 is the photograph of the MMIC chip, which is fabricated using a commercial InGaP/GaAs HBT foundry process and its size is as small as 1mm X 1mm. the power amplifier is designed for cellular band operation at the 824MHz to 849MHz.

3. Measurement

Fig. 3 shows the idle current of drive and power stage by the variation of Vctrl. The power stage’s current is varied from 8mA to 63mA. Fig. 4 is the ACPRs versus output power (Pout) in the variation of Vctrl using the reverse-link IS-95A signal with chip rate of 1.2288Mcps at 836.5 MHz. When the Vctrl is 1.7V, power amplifier is normal operation of the Class AB. The ACPR at 885 KHz offset is below 47.3dBc.

Fig. 5 shows the Gain & PAE Vs Pout of the normal operation and continuous bias control operation. The PAE is about 42.3% at 28dBm in both operations. The gain varies 16.6~26.2dB in bias control operation.

Fig. 6 shows the PDF function in suburban and urban in CMDA environments, and the DC Current of the both operations. The total quiescent bias currents are 71mA in normal operation, 17mA in continuous bias control mode, respectively. Table 1 shows the average currents of both operations in CDMA environments. The average current is reduced from 82.4 to 37.9 in urban environment, 97.6 to 59.2 in suburban by the bias control.

4 Conclusion

It has been shown that a CDMA handset power amplifier with continuous bias control circuit can increase the standby and talk time by lowering the expected and average current consumption. There is significant reduction in current consumption at continuous bias controlled operation with comparable performance at normal Class AB operation. The average current of the continuous bias control is 37.9 mA in urban and 59.2mA in suburban CDMA environment, which is reduced by 45.9% and 60.6% respectively, compared to normal operation (no bias control). The ACPR is below 47.3dBc, and the PAE is about 42.3% in both operations.

References

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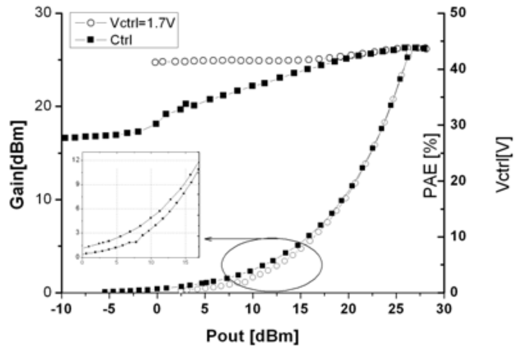


Fig 1 the Deisigned PA schematic

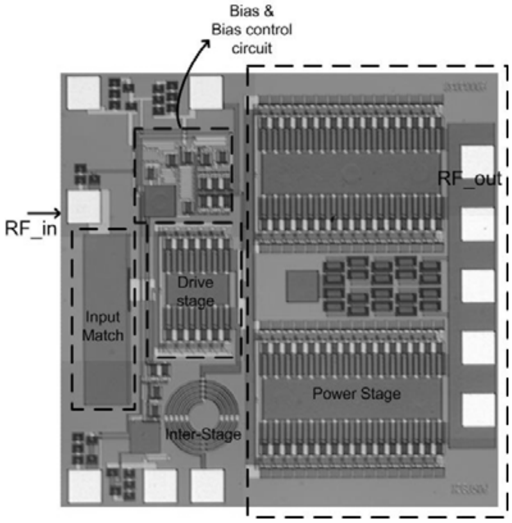


Fig 2 The Photo of MMIC PA

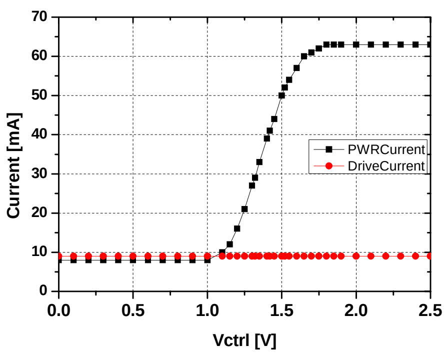


Fig 3 Idle Current Vs. Vctrl at each stage

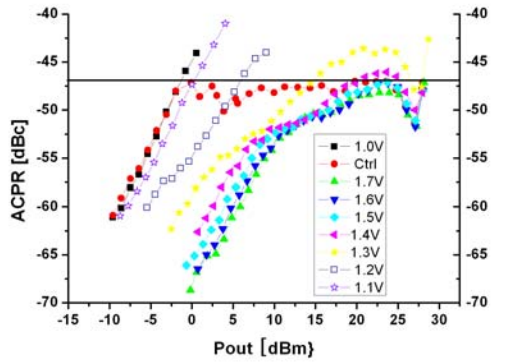
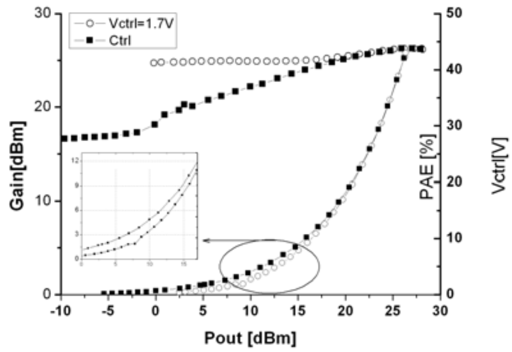


Fig 4. ACPR Vs Pout in the variation of Vctrl



Figi 5. Efiiciency & Gain Vs. Pout

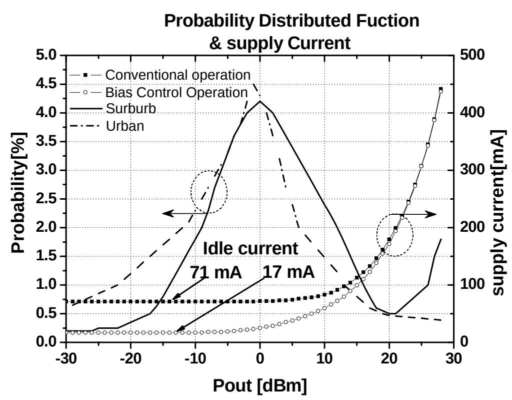


Fig 6. Idle PDF & DC Current Vs Pout

Urban		Suburban.	
AB	Ctr	AB	Ctr
82.4	37.9	97.6	59.2

Table 1 expectatation current